

a three-stage adaptive recursive filter having the prefiltered output and the motion-corrected output as inputs, the three stages comprising:

- a first stage that comprises a function that selects between using static pixels data and moving pixels data from a next field;
- a second stage that comprises a function that selects a more valid set of data between motion compensated data from a previous field and the pixels selected by the first stage; and
- a third stage that comprises a function that combines an intra-field interpolation with the more valid set of data selected by the second stage.

31. (Original) An interlace-to-progressive scan conversion system, comprising:
- a spatial line averaging prefilter having a prefiltered signal as an output;
 - a motion estimator having the prefiltered signal as input and a motion-corrected signal as an output, the motion estimator comprising: a 3-D recursive search sub-component; a motion vector correction sub-component; and a block erosion sub-component; wherein:
 - the 3-D recursive search sub-component includes a bilinear interpolator defined by:

$$F(x, y, t) = (yf \cdot xf \cdot F(xi, yi, t)) + (yf \cdot (1 - xf) \cdot F(xi + 1, yi, t)) + ((1 - yf) \cdot xf \cdot F(xi, yi + 1, t)) + ((1 - yf) \cdot (1 - xf) \cdot F(xi + 1, yi + 1, t))$$

where:

$$yf = \lfloor y \rfloor \quad xf = \lfloor x \rfloor \quad (3.4)$$

and:

$$yi = y - \lfloor y \rfloor \quad xi = x - \lfloor x \rfloor \quad (3.5)$$

and wherein a value of a first estimator is set to a value of a second estimator if:

$$e(\overline{MV}_a, \bar{X} - \overline{SMV}_a, t) > e(\overline{MV}_b, \bar{X} - \overline{SMV}_b, t) + Th$$

and wherein the value of the second estimator is set to the value of the first estimator if:

$$e(\overline{MV}_b, \bar{X} - \overline{SMV}_b, t) > e(\overline{MV}_a, \bar{X} - \overline{SMV}_a, t) + Th$$

where Th is a fixed threshold;

the 3-D recursive search sub-component has a look-up table consisting of:

$$US_n = \left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \end{pmatrix}, \begin{pmatrix} 0 \\ -1 \end{pmatrix}, \begin{pmatrix} 1 \\ 0 \end{pmatrix}, \begin{pmatrix} -1 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 2 \end{pmatrix}, \begin{pmatrix} 0 \\ -2 \end{pmatrix}, \begin{pmatrix} 3 \\ 0 \end{pmatrix}, \begin{pmatrix} -3 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ \frac{1}{4} \end{pmatrix}, \begin{pmatrix} 0 \\ -\frac{1}{4} \end{pmatrix}, \begin{pmatrix} \frac{1}{4} \\ 0 \end{pmatrix}, \begin{pmatrix} -\frac{1}{4} \\ 0 \end{pmatrix} \right\}$$

a motion vector correction sub-component having an motion vector error

correction function defined by:

$$\overline{MV}(x, y, t) = \begin{cases} \begin{pmatrix} 0 \\ 0 \end{pmatrix}, & (e_m(x, y, t) \geq e_s(x, y, t)) \\ \overline{MV}(x, y, t), & (e_m(x, y, t) < e_s(x, y, t)) \end{cases}$$

where:

$$e_m(x, y, t) = \sum |F(C) - F(D)|$$

$$e_s(x, y, t) = \sum |F(A) - F(B)|$$

and where A, B, C, D , and X are blocks containing ends of

candidate motion vectors, X being in the current field, A and C

being in the previous field, and B and D being in the next field;

a block erosion sub-component that divides each block according to:

$$B(x, y, t) = \{(x, y) | X_x - X/2 \leq x \leq X_x + X/2 \wedge X_y - Y/2 \leq y \leq X_y + Y/2\}$$

wherein a vector $\overline{MV}(x, y, t)$ is assigned, into four sub-blocks $B_{i,j}(x, y, t)$

$$B_{i,j}(x, y, t) = \{(x, y) | X_x - (1-i) \cdot \frac{X}{4} \leq x \leq X_x + (1+i) \cdot \frac{X}{4} \wedge X_y - (1-j) \cdot \frac{Y}{4} \leq y \leq X_y + (1+j) \cdot \frac{Y}{4}\}$$

and wherein the variables i and j take the values $+1$ and -1 ; wherein a vector $MV_{ij}(x, y,$

$t)$ is assigned to the pixels of each of the sub-blocks $B_{ij}(x, y, t)$:

$$\forall (x, y) \in B_{i,j}(x, y, t) : \overline{MV}_{i,j}(x, y, t) = \overline{MV}_{i,j}(\bar{X}, t)$$

wherein:

$$\overline{MV}_{i,j}(\bar{X}, t) = \text{med}[\overline{MV}(x + i \cdot X, y, t), \overline{MV}(\bar{X}, t), \overline{MV}(x, y + j \cdot Y, t)]$$

wherein the median function is a median on the x and y vector components separately;

and

wherein a resulting vector is replaced by an original motion vector unless the resulting

vector is equal to one of the three input vectors;

a three-stage adaptive recursive filter having the prefiltered signal and motion-

corrected signals as output, the three stages comprising:

a first stage comprises a function that selects between using static pixels

data and moving pixels data from a next field according to the

function:

$$F_n(x, y, t) = \begin{cases} F(x + MV_x(x, y, t), y + MV_y(x, y, t), t + 1), & (D_m < D_s) \\ F(x, y, t + 1), & (D_m \geq D_s) \end{cases}$$

where:

$$D_s = \sum_{k=-2}^2 C_v(k) \cdot |F(x, y + k, t) - F(x, y + k, t + 1)|$$

$$D_m = \sum_{k=-2}^2 C_v(k) \cdot |F(x, y + k, t) - F(x - MV_x(x, y, t), y - MV_y(x, y, t) + k, t + 1)|$$

a second stage comprises a function that selects a more valid set of data

between motion compensated data from a previous field and the

pixels selected by the first stage; and

a third stage comprises a function that combines an intra-field

interpolation with the more valid set of data selected by the second

stage according to the function:

$$F_o(x, y, t) = \begin{cases} F(x, y, t), & (y \bmod 2 = t \bmod 2) \\ (c_i \cdot F_i(x, y, t)) + (1 - c_i)(c_p \cdot F_p(x, y, t) + (1 - c_p)F_n(x, y, t)), & (\text{otherwise}) \end{cases}$$

wherein c_i and c_p are adaptive coefficients ranging from 0 to 1; F_n

is given by:

$$F_n(x, y, t) = \begin{cases} F(x + MV_x(x, y, t), y + MV_y(x, y, t), t + 1), & (D_m < D_s) \\ F(x, y, t + 1), & (D_m \geq D_s) \end{cases}$$

wherein intra-field interpolation is given by:

$$F_i(x, y, t) = \frac{F(x, y - 1, t) + F(x, y + 1, t)}{2}$$

and wherein backward data prediction is given by:

$$F_p(x, y, t) = F(x - MV_x(x, y, t), y - MV_y(x, y, t), t - 1),$$

32. (Original) A method for converting an interlaced image to a progressive scan image, the method comprising:

providing an input signal corresponding to an image;

prefiltering the input signal with a spatial line averaging prefilter;

estimating motion in the image by:

performing a 3-D recursive search;

performing a motion vector correction;